DOES INNOVATION REALY DRIVE ECONOMIC GROWTH?

Master Thesis Research

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To Whom It May Concern

This is to certify that the paper titled 'Does innovation really drive economic growth?' by Mehmet Cakir satisfies the requirement for ECON8091: Masters Thesis Research.

Sincerely,

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ABSTRACT

The purpose of this paper is to investigate whether economic growth can be explained by changes in innovation spending, new goods and institutions. Moreover, it will be shown whether there are any differences in innovation spending, new goods and institutions among countries. Turkey, USA, Korea, and Greece are taken as example countries and Granger- Causality test is applied all those countries' data sets. The tests results show that economic growth can be explained by changes in innovation spending, new goods and institutions for some countries. Roughly, those countries have some similarities like those countries are frontier countries. Countries, which are follower, the results are not the same.

INTRODUCTION

Since the birth of economics, economic growth has been defined in standard economics textbooks as an increase in the production and consumption of goods and services. It has become one of the economic purposes worldwide for policy makers and most of them have been evaluated by economic agents with sustainable economic growth in their periods. In spite of its classic definitions, economic growth has identified with innovations, new goods and new markets.

A large group of researchers argue that economic growth has considerable consequence on innovation spending and new goods. Demand on new goods increases consumption spending and this consumption behavior leads to new investment in this area.

The purpose of this paper is to investigate whether economic growth can be explained by changes in innovation spending, new goods and institutions. Moreover, it will be shown whether there are any differences in innovation spending, new goods and institutions among countries. The paper has several sections: section 2 presents the literature background; section 3 reviews economic growth, innovation spending, new goods, institutions trends and data; section 4 analyzes relationships between economic growth and innovation spending, new goods, institutions and shows examples of different countries; and section 5 concludes the paper.

2. Literature Reviews

Economics has a lot of issue that most economist don't agree on about solutions or methods even if the results will be the same. However, economists widely agree on long-term growth is a result of innovation and technological development. Literature review roughly divide to parts: first part is the Schumpeterian approach; second part is Neoclassical growth models. Nevertheless, before mentioning these two parts, Adam Smith who is the father of the economics pin factory example will be a good example how innovation changes output thereby GDP.

Adam Smith describes a pin factory where around ten workers work and each worker makes one pin in a day, and certainly could not make twenty in a classical method. But, then factory divided into a number of branches: one man draws out the wire; another straights it; a third cuts it; a fourth points it; a fifth grinds it; another whitens them; and another put them in to paper. Thanks to division of labor, the factory produces around twelve pounds of pins in a day, it means forty-eight thousand pins in a day (Smith, 2012). The innovation in division of labor increased output more than hundreds times and this example can be thought first innovation example that increase the output.

A-The Schumpeterian Approach

Schumpeter is one of the people who mentions innovation is the key role of economic growth. He described his work as;

> *In capitalist reality as distinguished from its textbook picture, it is not that kind of competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization (the largest-scale unit of control for instance)—competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives* (Schumpeter, 1975).

This study was summarized based on three main ideas: (i) it is about growth generated by innovations; (ii) innovations result from entrepreneurial investments that are themselves motivated by the prospects of monopoly rents; and (iii) new innovations replace old technologies: in other words, growth involves creative destruction (Philippe Aghion, 2014).

Schumpeter's study was descriptive and the formal ways of his study has been described by later economists.

B-Neoclassical Growth Models

Robert Solow developed a formal neoclassical growth model, based on the concepts of production function that output is a function of inputs (capital, labor, technology, and population), and reaches a long run equilibrium(Solow, 1956). This description can be formulized as;

Solow began with a production function of the Cobb-Douglas type:

$$Q = A\,K^{a}L^{b}$$

where A is multifactor productivity, a + b < 1, indicating diminishing returns to scale, a + b > 1, indicating increasing returns to scale and a + b = 1, indicating constant returns to scale.

Any increase in Q could come from: K, L, and A. To measure output for each labor, output is divided by labor

$$Q / L = A\,K^{a}L^{b-1} = A\,K^{a}/\,L^{1-b}$$

since multiplying byL^{b-1} is the same as dividing by L^{1-b}. Also, since we assumed that a + b = 1, a = 1 - b.

$$Q = A\,\frac{K^{a}}{L^{a}} = A(K/L)^{a}$$

Defining q = Q / L and k = K / L, that is, letting small letters equal per capita variables

q = A k a

which is the key formula that explains economic growth and its elements. We will examine how the model works when growth comes through capital accumulation, and how it works when growth is due to innovation.

3- Data

In this study, spending on research and development, number of patents and long term interest rate have been used to explain change in GDP. Spending on research and development has been chosen, since most studies show that there is a relationship between them, but they do not explain the power of relationship. Also, number of patents can be result of innovation spending and it is obvious that it affects GDP. In addition to those two variable, interest rate has been chosen, since interest rate is highly important for spending, saving and investment that are have direct effect on GDP. An increase in interest rate can lead to decrease in spending on research and development, since entrepreneur can choose interest revenue instead of spending on research and development.

GDP can fluctuate quite heavily over short periods of time; thus, quarterly data was the minimum time period. Some countries' data have been chosen yearly, since quarter data are not available for all countries. However, yearly data have been converted to quarterly by using Linear-match last method.

For GDP, spending on research and development, and number of patents, data are available on OECD statistics. For interest rate, data haven been gathered from OECD statistics, World Bank, IMF and FRED statistics. However, some values are still missing. In order to fill out the missing values, linear interpolation has been used. This is a commonly used method to find unknown variable estimates through the use of a straight line between two known values. The value that lies in between is the estimated value. The formula for linear interpolation: Unknown value = *V1+(V2-V1) * (tn-t1) / (t2-t1)*. Where V1 is value 1, V2 is value 2, t2 time at 2, t1 at time 1 and tn is the time value at the unknown point. All variables are time series data that are generally between 1985 and 2013, and taken in LOG except for interest rate. Moreover, all variables are checked whether they are stationary or not.

4- Empirical study

The purpose of this study is to investigate whether there is any influence of the explanatory variables which are spending on research and development, number of patents, and interest rate on economic growth or vice versa. A formal way to statistically test for whether one variable leads another is known as Granger Causality tests (Seth, 2016). In the Granger-sense X is a cause of Y if it is useful in forecasting Y. In this framework "useful" means that X is able to increase the accuracy of the prediction of Y with respect to a forecast, considering only past values of Y. Such a test will not only test the relationship between two variables but which of the variables that affect each other. For example, changes in the innovation spending might affect GDP, but changes in GDP might not affect innovation spending. Testing causality, in the Granger sense, involves using F-tests to test whether lagged information on a variable Y provides any statistically significant information about a variable X in the presence of lagged X. If not, then "Y does not Granger-cause X" (Ghalayini, 2011). The formula for Granger Causality:

1) $GDPt= C0+\Sigma\alpha i\ GDPt\text{-}i+ \Sigma\beta i\ It\text{-}i + \varepsilon t$ i= 1 to n

2) $I_t = C_0 + \Sigma \alpha_i I_{t-i} + \Sigma \beta_i GDP_{t-i} + \varepsilon_t$ i= 1 to n

equation 1. The counterpart that GDP is affecting the innovation spending is specified if the opposite results are obtained, equation 2. If both coefficients are statistically different from zero, we will have bilateral causality where both variables are affecting each other.

4.1 Causality test Results

alpha= 0.05

	Null Hypothesis	Observation	Lags	P-value	Result
Turkey	GDP does not Granger Cause R&D	92	4	2.2e-16	Reject the Null
	R&D does not Granger Cause GDP	92	4	7.719	H0 accepted
USA	GDP does not Granger Cause R&D	112	6	2.2e-16	Reject the Null
	R&D does not Granger Cause GDP	112	6	0.000607	Reject the Null
KOREA	GDP does not Granger Cause R&D	112	4	5.039e-12	Reject the Null
	R&D does not Granger Cause GDP	112	4	8.778e-05	Reject the Null

GREECE	GDP does not Granger Cause R&D	88	2	0.3913	H0 accepted
	R&D does not Granger Cause GDP	88	2	0.0387	Reject the Null

5. Conclusion

The purpose of this paper is to investigate if economic growth can be explained by changes in spending on research and development. Also, it was investigated if there are any differences in spending on research and development effects on economic growth between countries.

The overall results proved to show that there is a clear relationship for the United States of America and Korea for spending on research and development and economic growth, vice versa.

For Turkey, although an increase in economic growth causes the increase in spending on research and development, an increase in spending on research and development does not cause the increase in economic growth.

For Greece, although an increase in economic growth does not cause the increase in spending on research and development, an increase in spending on research and development causes the increase in economic growth.

The results for the United States and Korea are the same the expected results like all other developed countries, but the results for Turkey and Greece are not the expected result. It can be because of several reasons: first off all, both countries lived several economic crises in this data periods; second, both counties' economy mostly depend on truism, agriculture and services and spending on research and development is generally technology; third, both countries may import their technology instead product themselves.

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